

IN THE CLAIMS:

1. (Currently Amended) A laser, comprising:

a medium doped with first ions that emit light at a laser wavelength as a result of the transition of electron energy from an upper energy level manifold to a lower energy level manifold;

a first pumplight aligned to couple energy into said medium at a first wavelength that excites a first portion of said first ions into said upper energy level manifold; and

a second pumplight aligned to couple energy into said medium at a second wavelength that excites a second portion of said first ions to a third energy level manifold, a fraction of which relax to said upper energy level manifold and thereby increase the total quantity of said first ions at said upper energy level manifold, increasing the energy emitted at said laser wavelength, wherein the energy coupled from said first pumplight and said second pumplight are synchronized in time.

2. (Original) The laser of Claim 1 wherein said medium is a crystal.

3. (Original) The laser of Claim 1 wherein said medium is selected from one of:  $\text{Sc}_2\text{SiO}_7$ ;  $\text{Sc}_2\text{SiO}_5$ ;  $\text{Y}_2\text{SiO}_5$ ;  $\text{Ca}_2\text{Al}_2\text{SiO}_7$ ;  $\text{Ca}_2\text{Ga}_2\text{SiO}_5$ ;  $\text{YVO}_4$ ,  $\text{BeAl}_2\text{O}_4$ , and similar materials including glasses.

4. (Original) The laser of Claim 1 wherein said medium is yttrium-aluminum-garnet.

5. (Original) The laser of Claim 1 wherein said first ions are erbium ions, and wherein said lower energy level manifold is the erbium  $^4\text{I}_{15/2}$  manifold, said upper energy level manifold is the erbium  $^4\text{I}_{13/2}$  manifold, and said third energy level manifold is the erbium  $^4\text{I}_{11/2}$  manifold.

6. (Currently Amended) The laser of Claim 5 wherein said first wavelength is near 1540\_nm, said second wavelength is near 980\_nm, and said laser wavelength is near 1640\_nm.

7. (Original) The laser of Claim 1 wherein said first pumplight is a light emitting diode array and said second pumplight is a erbium: fiber laser that emits energy at a wavelength near 980 nanometers.

8. (Currently Amended) The laser of Claim 1, further comprising a Q-switch disposed at an end of said medium through which said emitted laser wavelength light exits said medium.

9. (Canceled)

10. (Currently Amended) The laser of Claim 9 1 wherein said first pumplight and said second pumplight energy coupling are synchronized such that they do not overlap in time.

11. (Currently Amended) The laser of Claim 9 1 wherein said first pumplight couples energy at said first wavelength for approximately four milliseconds, and said second pumplight subsequently couples energy at said second wavelength for approximately two milliseconds.

12. (Original) The laser of Claim 1 further comprising second ions doped into said medium and wherein said second wavelength energy indirectly excites said second portion of said first ions by directly exciting a portion of said second ions to an increased energy level manifold that induces an inter-ionic energy transfer to said second portion of said first ions.

13. (Original) The laser of Claim 12 wherein said first ions are erbium ions and said second ions are ytterbium ions.

14. (Original) The laser of Claim 13 wherein said increased energy level manifold is the ytterbium  $^2F_{5/2}$  manifold, said lower energy level manifold is the erbium  $^4I_{15/2}$  manifold, said upper energy level manifold is the erbium  $^4I_{13/2}$  manifold, and said third energy level manifold is the erbium  $^4I_{11/2}$  manifold.

15. (Currently Amended) The ~~Laser~~ laser of Claim 13 wherein said first wavelength is near 1540 nm, said second wavelength is near 940 nm and said laser wavelength is near 1640 nm.

16. (Original) A laser comprising:

a medium formed from erbium ion doped yttrium-aluminum-garnet that emits laser light near 1640 nanometer wavelength as a result of the transition of electron energy from the erbium ion  $^4I_{13/2}$  energy level manifold to the erbium ion  $^4I_{15/2}$  energy level manifold;

a diode array pumplight aligned to couple energy near 1540 nanometer wavelength, for a first period of time that is approximately four milliseconds in duration, into said medium and thereby excite a first portion of said erbium ions into the erbium  $^4I_{13/2}$  energy level manifold;

an erbium: fiber laser pumplight aligned to couple energy near 980 nanometers, for a subsequent period of time that is approximately two milliseconds in duration, into said medium and thereby excite a second portion of said erbium ions into the erbium ion  $^4I_{11/2}$  energy level manifold, a fraction of which relax to the erbium ion  $^4I_{13/2}$  energy level manifold and thereby increase the total quantity of said erbium ions at said  $^4I_{13/2}$  manifold; and

a Q-switch disposed at an end of said medium through which said emitted laser wavelength light exits said medium.

17. (Original) A laser comprising:

a medium formed from erbium ion and ytterbium ion doped yttrium-aluminum-garnet that emits laser light near 1640 nanometer wavelength as a result of the transition of electron energy from the erbium ion  $^4I_{13/2}$  energy level manifold to the erbium ion  $^4I_{15/2}$  energy level manifold;

a first diode array pumplight aligned to couple energy near 1540 nanometer wavelength, for a first period of time that is approximately four milliseconds in duration, into said medium and thereby excite a first portion of said erbium ions into the erbium  $^4I_{13/2}$  energy level manifold;

a second diode array pumplight aligned to couple energy near 940 nanometers, for a subsequent period of time that is approximately two milliseconds in duration, into said medium and thereby excite a portion of said ytterbium ions into the ytterbium  $^2F_{5/2}$  energy level manifold, which induces an inter-ionic energy transfer to the erbium ion  $^4I_{11/2}$  manifold, a fraction of which relax to the erbium ion  $^4I_{13/2}$  energy level manifold and thereby increase the total quantity of said erbium ions at said  $^4I_{13/2}$  manifold; and

a Q-switch disposed at an end of said medium through which said emitted laser wavelength light exits said medium.

18. (Currently Amended) A method of producing laser light in a laser having a medium doped with first ions that emit light at a laser wavelength as a result of the transition of electron energy from an upper energy level manifold to a lower energy level manifold, and having a first pumplight operable to output energy at a first wavelength, and a second pumplight operable to output energy at a second wavelength, the method comprising the steps of:

coupling energy at the first wavelength from the first pumplight into the medium, thereby exciting a first portion of the first ions into the upper energy level manifold; ~~and~~

coupling energy at the second wavelength from the second pumplight into the medium, thereby exciting a second portion of the first ions to a third energy level manifold, a fraction of which relax to said upper energy level manifold, thereby increasing the total quantity of the first ions at the upper energy level manifold, and increasing the energy emitted at said laser wavelength; and

synchronizing the coupling of energy from the first pumplight and the second pumplight.

19. (Original) The method of Claim 18 wherein the medium is a crystal.

20. (Original) The method of Claim 18 wherein the medium is yttrium-aluminum-garnet.

21. (Original) The method of Claim 18 wherein the first ions are erbium ions, and wherein the lower energy level manifold is the erbium  $^4I_{15/2}$  manifold, the upper energy level manifold is the erbium  $^4I_{13/2}$  manifold, and said third energy level manifold is the erbium  $^4I_{11/2}$  manifold.

22. (Currently Amended) The method of Claim 21 wherein the first wavelength is near 1540\_nm, the second wavelength is near 980\_nm, and the laser wavelength is near 1640\_nm.

23. (Original) The method of Claim 18 wherein the first pumplight is a light emitting diode array and the second pumplight is an erbium: fiber laser that emits energy at a wavelength near 980 nanometers.

24. (Original) The method of Claim 18 wherein the laser further includes a Q-switch disposed at an end of the medium, further comprising the step of emitting the laser light through the Q-switch upon reaching the switching threshold of the Q-switch, thereby emitting a short pulse of laser light.

25. (Canceled)

26. (Currently Amended) The method of Claim ~~25~~ 18 wherein said synchronizing step is accomplished such that the coupling of the first pumplight energy and the second pumplight energy do not overlap in time.

27. (Currently Amended) The method of Claim ~~25~~ 18 wherein the first pumplight couples energy at the first wavelength for approximately four milliseconds, and the second pumplight subsequently couples energy at the second wavelength for approximately two milliseconds.

28. (Original) The method of Claim 18 wherein second ions are doped into the medium, further comprising the step of indirectly exciting the second portion of the first ions by directly exciting a portion of the second ions to an increased energy level manifold that induces an inter-ionic energy transfer to the second portion of the first ions.

29. (Original) The method of Claim 28 wherein the first ions are erbium ions and the second ions are ytterbium ions.

30. (Original) The method of Claim 29 wherein the increased energy level manifold is the ytterbium  $^2F_{5/2}$  manifold, the lower energy level manifold is the erbium  $^4I_{15/2}$  manifold, the upper energy level manifold is the erbium  $^4I_{13/2}$  manifold, and the third energy level manifold is the erbium  $^4I_{11/2}$  manifold.

31. (Currently Amended) The method of Claim 29 wherein the first wavelength is near 1540\_nm, the second wavelength is near 940\_nm and the laser wavelength is near 1640\_nm.

32. (New) A laser comprising:

a medium doped with first ions that emit light at a laser wavelength as a result of the transition of electron energy from an upper energy level manifold to a lower energy level manifold and second ions doped into said medium;

a first pump light aligned to couple energy into said medium at a first wavelength that excites a first portion of said first ions into said upper energy level manifold; and

a second pump light aligned to couple energy into said medium at a second wavelength that excites a second portion of said first ions to a third energy level manifold, a fraction of which relax to said upper energy level manifold and thereby increase the total quantity of said first ions at said upper energy level manifold, increasing the energy emitted at said laser wavelength,

wherein said second wavelength energy indirectly excites said second portion of said first ions by directly exciting a portion of said second ions to an increased energy level manifold that induces an inter-ionic energy transfer to said second portion of said first ions.

33. (New) The laser of Claim 32 wherein said medium is a crystal.

34. (New) The laser of Claim 32 wherein said medium is selected from one of:  $\text{Sc}_2\text{SiO}_7$ ;  $\text{Sc}_2\text{SiO}_5$ ;  $\text{Y}_2\text{SiO}_5$ ;  $\text{Ca}_2\text{Al}_2\text{SiO}_7$ ;  $\text{Ca}_2\text{Ga}_2\text{SiO}_5$ ;  $\text{YVO}_4$ ,  $\text{BeAl}_2\text{O}_4$ , and similar materials including glasses.

35. (New) The laser of Claim 32 wherein said medium is yttrium-aluminum-garnet.

36. (New) The laser of Claim 32 wherein said first ions are erbium ions, and wherein said lower energy level manifold is the erbium  $^4\text{I}_{15/2}$  manifold, said upper energy level manifold is the erbium  $^4\text{I}_{13/2}$  manifold, and said third energy level manifold is the erbium  $^4\text{I}_{11/2}$  manifold.

37. (New) The laser of Claim 36 wherein said first wavelength is near 1540 nm, said second wavelength is near 980 nm, and said laser wavelength is near 1640 nm.

38. (New) The laser of Claim 32 wherein said first pump light is a light emitting diode array and said second pump light is an erbium: fiber laser that emits energy at a wavelength near 980 nanometers.

39. (New) The laser of Claim 32 further comprising a Q-switch disposed at an end of said medium through which said emitted laser wavelength light exits said medium.

40. (New) The laser of Claim 32 wherein the energy coupled from said first pump light and said second pump light are synchronized in time.

41. (New) The laser of Claim 40 wherein said first pump light and said second pump light energy coupling are synchronized such that they do not overlap in time.

42. (New) The laser of Claim 32 wherein said first pumpflight couples energy at said first wavelength for approximately four milliseconds and said second pumpflight subsequently couples energy at said second wavelength for approximately two milliseconds.

43. (New) The laser of Claim 32 wherein said first ions are erbium ions and said second ions are ytterbium ions.

44. (New) The laser of Claim 43 wherein said increased energy level manifold is the ytterbium  $^2F_{5/2}$  manifold, said lower energy level manifold is the erbium  $^4I_{15/2}$  manifold, said upper energy level manifold is the erbium  $^4I_{13/2}$  manifold, and said third energy level manifold is the erbium  $^4I_{11/2}$  manifold.

45. (New) The laser of Claim 43 wherein said first wavelength is near 1540 nm, said second wavelength is near 940 nm and said laser wavelength is near 1640 nm.

46. (New) A method of producing laser light in a laser having a medium doped with first ions that emit light at a laser wavelength as a result of the transition of electron energy from an upper energy level manifold to a lower energy level manifold, and having a first pumpflight operable to output energy at a first wavelength; and a second pumpflight operable to output energy at a second wavelength, the method comprising the steps of:

coupling energy at the first wavelength from the first pumpflight into the medium, thereby exciting a first portion of the first ions into the upper energy level manifold;

coupling energy at the second wavelength from the second pumpflight into the medium, thereby exciting a second portion of the first ions to a third energy level manifold, a fraction of which relax to said upper energy level manifold, thereby increasing the total quantity of the first ions at the upper energy level manifold, and increasing the energy emitted at said laser wavelength, and

indirectly exciting the second portion of the first ions by directly exciting a portion of second ions in the medium to an increased energy level manifold that induces an ionic energy transfer to the second portion of the first ions.



47. (New) The method of Claim 46 wherein the medium is a crystal.

48. (New) The method of Claim 46 wherein the medium is yttrium-aluminum-garnet.

49. (New) The method of Claim 46 wherein the first ions are erbium ions, and wherein the lower energy level manifold is the erbium  $^4I_{15/2}$  manifold; the upper energy level manifold is the erbium  $^4I_{13/2}$  manifold; and said third energy level manifold is the erbium  $^4I_{11/2}$  manifold.

50. (New) The method of Claim 49 wherein the first wavelength is near 1540 nm, the second wavelength is near 980 nm, and the laser wavelength is near 1640 nm.

51. (New) The method of Claim 46 wherein the first pumplight is a light emitting diode array and the second pumplight is an erbium: fiber laser that emits energy at a wavelength near 980 nanometers.

52. (New) The method of Claim 46 wherein the laser further includes a Q-switch disposed at an end of the medium, further comprising the step of emitting the laser light through the Q-switch upon reaching the switching threshold of the Q-switch, thereby emitting a short pulse of laser light.

53. (New) The method of Claim 46 further comprising the step of synchronizing the coupling of energy from the first pumplight and the second pumplight.

54. (New) The method of Claim 46 wherein said synchronizing step is accomplished such that the coupling of the first pumplight energy and the second pumplight energy do not overlap in time.

55. (New) The method of Claim 46 wherein the first pumplight couples energy at the first wavelength for approximately four milliseconds, and the second pumplight

subsequently couples energy at the second wavelength for approximately two milliseconds.

56. (New) The method of Claim 46 wherein the first ions are erbium ions and the second ions are ytterbium ions.

57. (New) The method of Claim 56 wherein the increased energy level manifold is the ytterbium  $^2F_{5/2}$  manifold, the lower energy level manifold is the erbium  $^4I_{15/2}$  manifold, the upper energy level manifold is the erbium  $^4I_{13/2}$  manifold, and the third energy level manifold is the erbium  $^4I_{11/2}$  manifold.

58. (New) The method of Claim 56 wherein the first wavelength is near 1540 nm, the second wavelength is near 940 nm and the laser wavelength is near 1640 nm.